

What is claimed is:

1. A charging voltage measuring apparatus for measuring a charging voltage  $V_s$  on the surface of a substrate on a substrate holding unit, comprising:
  - 5 a measuring electrode, for forming an electrostatic capacity  $C_s$  with said substrate, being disposed on said substrate holding unit to make contact with or proximate to the back face of said held substrate, and said measuring electrode being electrically insulated from said substrate holding unit;
  - 10 a measuring capacitor connected between said measuring electrode and a ground potential portion, said measuring capacitor having an electrostatic capacity  $C_m$ ;
  - 15 a voltage measuring unit for measuring a measuring voltage  $V_m$  between both ends of said measuring capacitor; and
  - 20 a calculating unit for calculating said charging voltage  $V_s$  in accordance with a following numerical expression 1 or its mathematically equivalent numerical expression on the basis of an inverse  $K$  of a voltage dividing ratio that is defined by the relation of said electrostatic capacities  $C_s$  and  $C_m$  and said measuring voltage  $V_m$ .

[Numerical expression 1]

$$V_s = K \times V_m$$

where  $K = (C_s + C_m) / C_s$  or  $K = C_m / C_s$  (if  $C_m \gg C_s$ )

2. A charging voltage measuring device apparatus for measuring a charging voltage  $V_s$  on the surface of a substrate held on a substrate holding unit, comprising:

5 a measuring electrode, for forming an electrostatic capacity  $C_s$  with said substrate, being disposed on said substrate holding unit to make contact with or proximate to the back face of said held substrate, and said measuring electrode being electrically insulated from said substrate holding unit;

10 a measuring capacitor connected between said measuring electrode and a ground potential portion, said measuring capacitor having an electrostatic capacity  $C_m$ ;

a voltage measuring unit for measuring a measuring voltage  $V_m$  between both ends of said measuring capacitor; and

15 a calculator calculating unit for calculating said charging voltage  $V_s$  at time  $t_1$  in accordance with a following numerical expression 2 or its mathematically equivalent numerical expression on the basis of an inverse  $K$  of a voltage dividing ratio that is defined by the relation between said

20 electrostatic capacities  $C_s$  and  $C_m$ , and said measuring voltage  $V_m(t_1)$  at time  $t_1$ , and a resistance value  $R_m$  of a resistor including an internal resistor of said voltmeter and disposed in parallel to said measuring capacitor, when the time is  $t$ , the measurement start time is  $t=0$ , and the measurement time

25 is  $t_1$ .

[Numerical expression 2]

$$V_s = K[V_m(t_1) + \{1/(C_m \times R_m)\} \int_0^{t_1} V_m(t) dt]$$

where  $K = (C_s + C_m)/C_s$  or  $K = C_m/C_s$  (if  $C_m >> C_s$ )

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3. An ion beam irradiating device apparatus for irradiating an ion beam onto a substrate held on a substrate holding unit, comprising:

an plasma generating source for generating and  
10 supplying electrons to said substrate to suppress the electrification on the surface of said substrate caused by irradiating said ion beam;

a charging voltage measuring device for the substrate according to claim 1; and

15 a controller unit for controlling an amount of electrons generated from said electron supply source on the basis of charging voltage  $V_s$  measured by said charging voltage measuring device;

wherein said control unit controls to maintain said  
20 amount of said electrons generated from said electron supply source when said charging voltage  $V_s$  is within a reference voltage range,

wherein said control unit controls to increase said amount of said electrons generated from said electron supply  
25 source when said charging voltage  $V_s$  is higher than said

reference voltage range, and

wherein said control unit controls to decrease said amount of said electrons generated from said electron supply source when said charging voltage  $V_s$  is lower than said reference voltage range.

4. An ion beam irradiating apparatus for irradiating an ion beam onto a substrate held on a substrate holding unit, comprising:

10 an plasma generating source for generating and supplying electrons to said substrate to suppress the electrification on the surface of said substrate caused by irradiating said ion beam;

15 a charging voltage measuring device for the substrate according to claim 2; and

a control unit for controlling an amount of electrons generated from said electron supply source on the basis of charging voltage  $V_s$  measured by said charging voltage measuring device;

20 wherein said control unit controls to maintain said amount of said electrons generated from said electron supply source when said charging voltage  $V_s$  is within a reference voltage range,

25 wherein said control unit controls to increase said amount of said electrons generated from said electron supply source

when said charging voltage  $V_s$  is higher than said reference voltage range, and

wherein said control unit controls to decrease said amount of said electrons generated from said electron supply source  
5 when said charging voltage  $V_s$  is lower than said reference voltage range.

5. The charging voltage measuring device according to claim 1, wherein said measuring electrode is a conductive  
10 plate covered with an insulating layer.

6. The charging voltage measuring device according to claim 2, wherein said measuring electrode is a conductive plate covered with an insulating layer.